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The NATURE, SOURCE AND COMPOSITION OF THE DUST STORMS IN TIKRIT/ IRAQ

Amera Ismail Hussain

Water Resources Department

Natural Resources Research Center
University of Tikrit/ Iraq

E-amer_hussain@yahoo.com

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Abstract:

Dust storms are a significant environmental problem. The present study deals with the nature, source and composition of the dust storm particles. Based on meteorological , geological and remote sensing data the source explained . Dust deposition quantity calculated which ranges between(107.44gm/m2 – 452.44 gm/m2) and the particle size distribution containing %23.52 of fine sand , %62.6 silt and %13.88 clay, as well as organic material was about(% 2.11) and CaCo3 (%25.9.(

Dust storms frequency noticed which is more than a week per month during eight months in 2007 starting in March and more than a week per month in nine months in 2008.In addition to the climate elements satellite images were used to detect the sources of the dust storms which varied from surrounded boarders to local sources

طبيعة ومصدر ومكونات العواصف الغبارية في تكريت /العراق

اميرة اسماعيل حسن

قسم الموارد المائية/ مركز بحوث الموارد الطبيعية / جامعة تكريت

الكلمات المفتاحية: العواصف الغبارية، كمية الترسبان، حجم الحبيبات، ترددات العواصف الغبارية، العناصر المناخية، الصور الفضائية.

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الخلاصة:

تعد العواصف الغبارية مشكلة بيئية. تتعامل الدراسة مع طبيعة ومصدر ومكونات الدقائق الغبارية.تم تحديد مصدر هذه العواصف بالاعتماد على البيانات المناخية ، والمعلومات الجيولوجية والتحسس النائي .تراوحت كميات الغبار المترسبة بين (107,44 غم/م2- 452,44 غم/م2). وحجم الحبيبات يتراوح بين (23,52%) من الرمل الناعم، و (62,6) من و(13,88) من البطن، من حيث تراوحت نسبة المواد العضوية حوالي 2,11% ونسبة كاربونات الكالسيوم25,9%.

Introduction:

Dust storm is an indication of unhealthy environment. Dust storm is a kind of severe environmental issues. In meteorology dust storm is a catastrophic atmospheric phenomenon which strong violent winds pick up and transport grains of fine particles like dust and silt from the ground, making the air hazy and restricting the horizontal visibility to less than 1 km. (Fan et al., 2002) and (Park etal,2003)

Dust storms are hazardous weather events. Dust particles can affect both regional and global environment such as visibility reduction, change of radiative forcing and detrimental effects on human health. (Min park et.al, 2003).

Sandstorms are common in Iraq's desert terrain, especially during the summer, when a strong northwesterly wind called the shamal blows over the floodplain of Iraq's Tigris and Euphrates Rivers. The wind was picking up dust at distinct point sources in the northwest. Dust rises from these sources in distinct plumes and blow southeast.

Severe dust storms occurs in Iraq which causes reduction in visibility and reaches less than 10 meters. Cities below latitude 35˚ N are affect mostly. The site of

Iraq which is location near desert margins, limited vegetation because of absence of rainfall, increase of wind speed, presence of dry plain land for a large distance and the landscape of hills and high lands in the east, north and west with the flat low lands in the south will increase the dust storm occurrence.(Muhamad, 1990) .Tikrit city is one of the most affected area by dust storms, each year dusts are blown towards the city from NW and W of Tikrit region.

Tikrit city is located on the western side of the Tigris river in the mid part of Iraq with longitude (42˚ 32' -44˚ 59') east and latitude (33˚ 27'00"-35˚41') north. as shown in (Figure-1). Dust storm is a common feature in the city of Tikrit (Salah Al- Din province) and in the late few years the dust effect most parts of Iraq, because of dry condition and

Desertification.

Figure -1: The location of the studied area (Tikrit city)

Climatology:

The climate changes are the main causes of land degradation as well as human activities have led to serious and widespread soil erosion and land degradation which led to desertification and sand dunes as well as dust storms and dust haze Batjargal,2004).The mean annual wind direction at Tikrit area from the available records for the period (1938-2000) indicate that the mean annul wind direction is north westerly and westerly direction. Wind velocity is greater during the day than at night and greater in the summer than in winter with the velocity of (2.5-3.5) m/sec.(Al- Jeboury, 2002) (Figure-2).

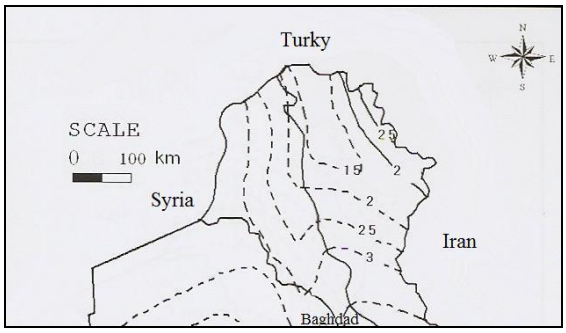


Figure-2: Annual wind velocity (m/sec) for (1941-1990).(From Iraqi Climate Observatory).

Tikrit recognized as rainless hot to very hot in summer and rainy winter with annual rainfall between (150-250)mm) as shown in Figure (3), and the minimum temperature in January (8-10)◦C. with maximum temperature reaches in July 44◦C as shown in Table -1- the monthly annual temperature for (1988-2001) is shown in (Figure 4) (Al-Jeboury,2002).

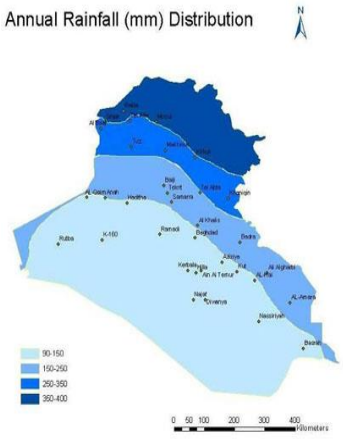


Figure-3: The annual rainfall (mm) distribution of Iraq.(Al-Aliy,2007)

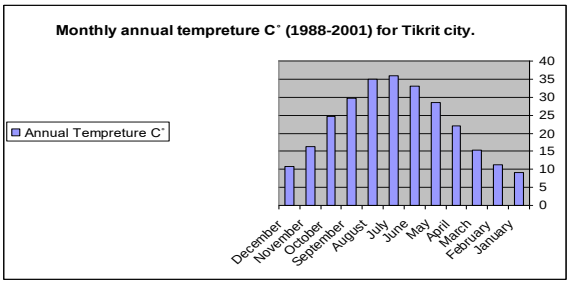


Figure – 4: Bar diagram shows the monthly annual temperature C for the studied area for the periods (1988-2001).(Modified from Al-Jibourie ,2002).

Table -1: Different climate elements for 2008 in the studied area.(Tikrit Meteorological Station).

Max. Temp.	Min. Temp.	Wind Velocity	Annual ainfall (mm**3)	Dusty Days	Year 2008
19	8	4	8	4	January
22	9	4	11.5	7	February
26	10	3	17.8	20	March
26	18	3	7	15	April
36.7	19.9	5	0	20	May
41.2	25	6	0	24	Jun
44	30	5	0	20	July
45	30.5	5	0	22	August
40.5	25.8	6	5	7	September
35	16.5	6	6.2	10	October
25	11	5	1.6	5	November
17.7	4.5	5	6.7	3	December

After 1995 Iraqi's summer climate despite of hot and dry became dusty and the temperature in summer reaches (48)◦C.

Size Distribution and Deposition Quantity of the Dust Particles:

When dust storm happens, a great deal of surface sand dust is blown up in to high sky by gales makes the air being dim and the horizontal visibility below (1000 m.). (Gao Tao, et.al. 2004)

For determining the particle size of the dust particles, samples were collected from different places in the city of Tikrit by placing containers for collecting the dust and in the end of the storm the retained dust were analyzed by hydrometer and found that the particle size distribution containing 23.52% of fine sand , 62.6% silt and %13.88 clay, and also the dust deposit composition showed that the percentage of $CaCO_3$ is (25.9)% and the percentage of organic material is(2.11%). (Table -2)

Table -2: Distribution of particle size, percentage of organic material and CaCO3 .

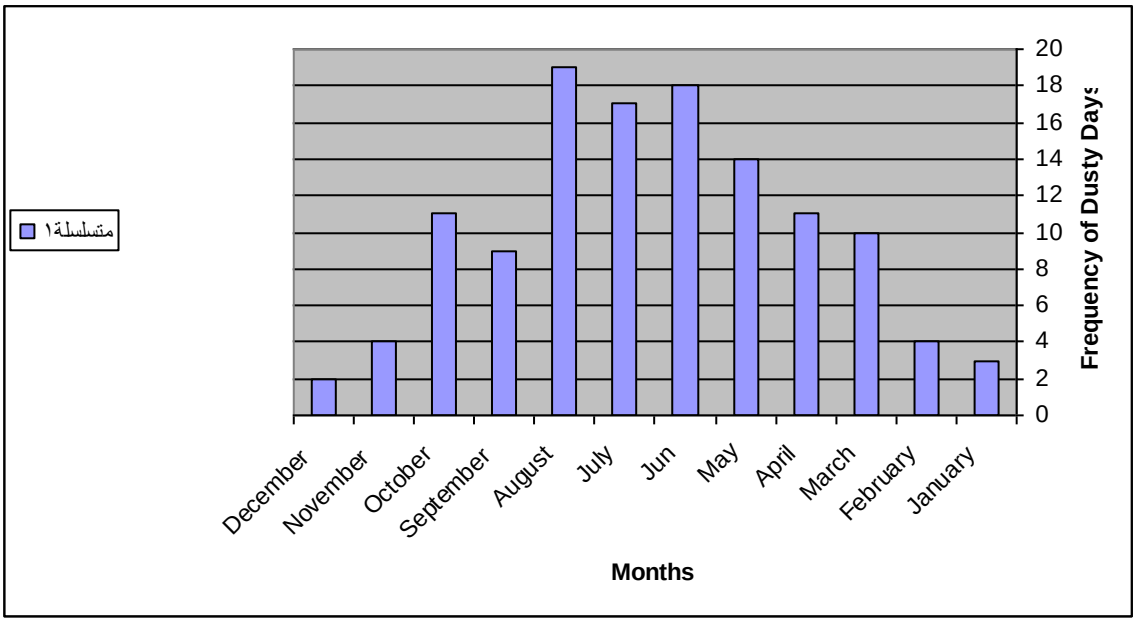
Date of sample collection	Fine sand %	Silt %	Clay %	Organic material %	CaCo3%
2007/5	28.6	59	12.4	1.21	26.8
2007/8	17	68	15	3.43	25.0
2008/5	20	66	14	2.25	25.9
2008/6	20	62	18	1.50	26.0
2008/8	32	58	10	2.20	25.8
Average	23.52	62.6	13.88	2.11	25.9

The monthly frequency distributions of dust storms in a period of two years(January 2007 to January 2009) were observed and are shown in (Figure-5). It is noted that the dust storm frequency more than a week per month is during eight months in 2007 which begins in march and in nine months during 2008 . (Table-3)

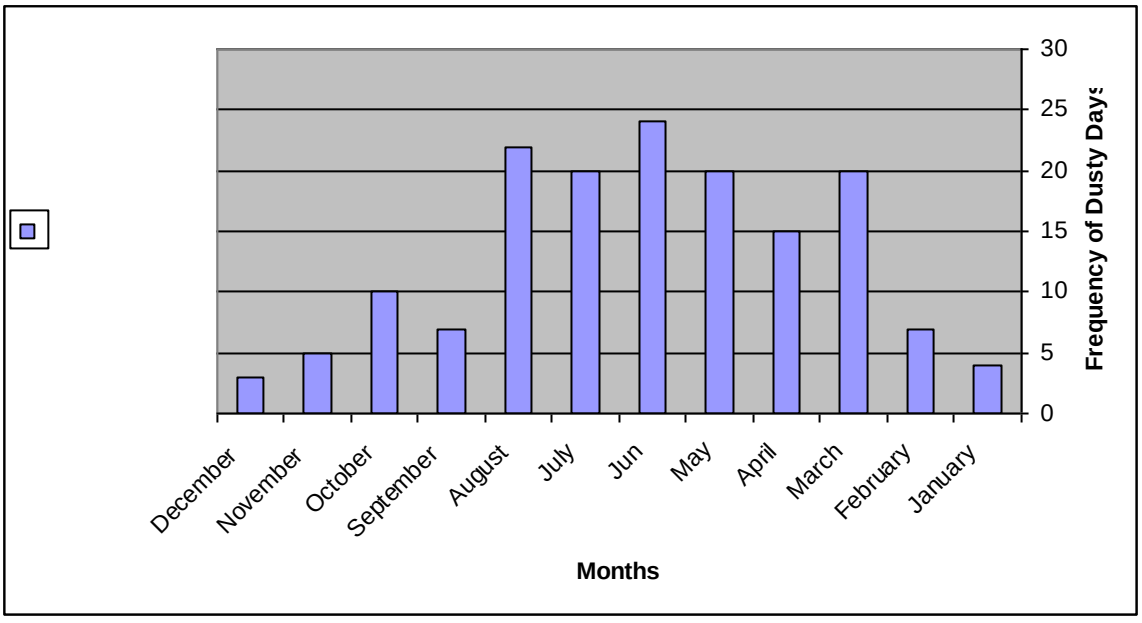
Table-3- Monthly frequency of dust storm in two years

Year 2007	Dusty Days	Year 2008	Dusty Days
January	3	January	4
February	4	February	7
March	10	March	20
April	11	April	15
May	14	May	20
June	18	June	24
July	17	July	20
August	19	August	22
September	9	September	9

October	11	October	10
November	4	November	5
December	2	December	3



(A)

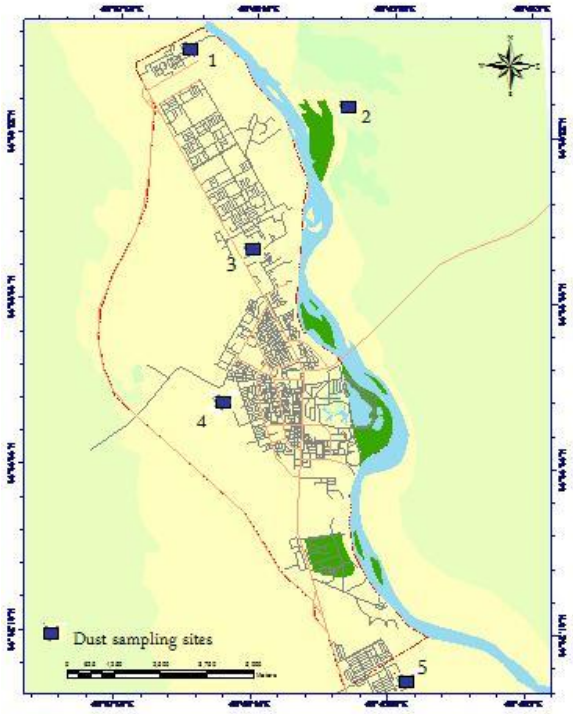


(B)

Figure-5: The monthly frequency distribution of dust storms, in years (a)2007 (b) 2008

The deposition rates of airborne dust in the end of the storm are calculated from five sites within studied area ,location of the different sites shown in (Figure-6).

It is noticed that different airborne dust quantity is deposited in different storms which ranged between (107.44) gram /square meters to (452.44) gram /square meters. Also Liu,2004 studied the dust fall in China western loess Plateau and concluded that the seasonal distribution of dust deposition mainly is in spring. and as well as monthly distribution of dust storm occurrence plotted.



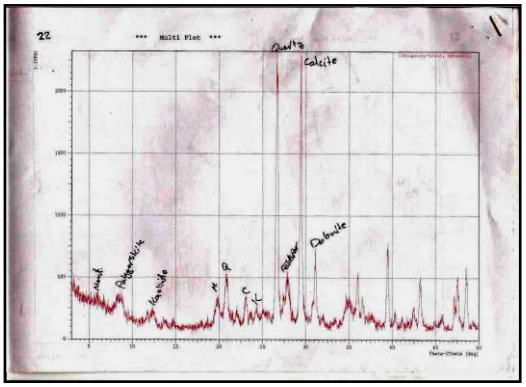
Figre-6:Location of the five sites for dust sampling in the studied area.

The X-Ray Diffraction of the Dust:

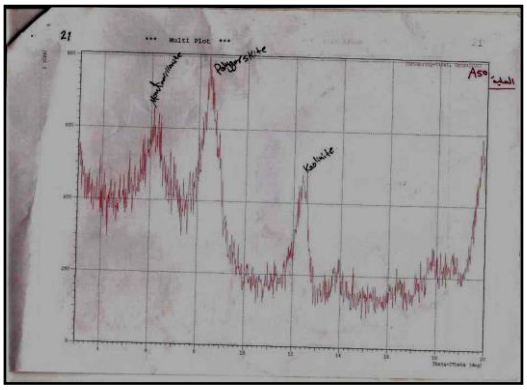
Two samples of the collect dust have been examined for mineralogical constituent and the following minerals have been recognized (Figure -7)

: 1- Quartz and silica which may derived from the surface friable sand sheets and sand dunes which cover large area in west Iraq.

2-Calcite and dolomite originated from carbonate rocks and calcite soil in the western desert of Iraq and from western borders.



(a)



(b)

Figure-7: X.R.D. for a representative two collected dust samples (a,b) indicates the different minerals.

3-Feldspars exist in low percentages and may reflected to the dry weathering of older clastic sediments in the area.

4- Montmorilonite and kaolinite clays are closely associated with Quaternary and older sediments and probably formed from feldspar and non-micaceous ferromagnesian minerals although they also form from mica (McMurty and Fan ,1974).

Also Montmorillonite is known to be formed by degradation of mica during weathering and subaqueous weathering acid volcanic ash usually produce montmorillonite .

5-Palygorskite present in minor amount and mostly of authiogenic origin as alternation from montmorillonite under certain conditions.

Also Palygorskite may derived from older formation in western desert of Iraq such as Tayarat Formation (upper Cretaceous),.

deposits of the Safra bed (Mastrichtian) in Ga'ara Akashat area, Injana Formation (Late-Miocene Pliocene) and other formations outcropped in the area (Al-bassam, 2000).Black shale and clay stone horizons are the most rich sediment in Palygorskite . (Al-Bassam,2000).

The Sources of Dust storm occurrence:

A dust storm arises when a gust front passes or when the wind force exceeds the threshold value where loose sand and dust are removed from the dry surface. Particles are transported by saltation and suspension causing erosion from one place and deposition in another. (Qian et al. 2002, Park et al,2003, Wikkipedia)

The entrainment of dust from the ground surface is controlled by the nature of the soil or sediment itself, as well as meteorological elements which dominated by the passage of low pressure fronts with intense baroclinal gradients that are accompanied by very high-velocity winds, such frontal passage is the dominant dust generating mechanism in many of the worlds dusty regions .(Yang, et al,2007)

Different terrain types vary greatly in their susceptibility to dust storm occurrence

. The most favorable dust producing surfaces are areas of bare, loose and mobile sediments containing substantial amounts of sand and silt but little clay.

Terrains that satisfy these conditions are most commonly found in geomorphologically active landscapes where tectonic movements, climatic changes and/or human disturbance are responsible for rapid exposure, incision and reworking of sediment formations containing dust. Important sources of dust storms are generally located in specific, relatively small desert environments (Coude-Gaussen1984 in Goudie, 2006) such as floodplains, alluvial fans, salt pans and devegetated fossil dunes. Dust storms can occur in any environment given appropriate conditions of bare unconsolidated sediment and a strong turbulent wind but they are most common in deserts and on their margins.

The important factors to dust storm occurrence is the soil cover and the soil particle size, Winds generated in areas with steep pressure gradients such as the north westerly shimal wind that blows down the Arabian Gulf from Iraq and Kuwait.
(Goudie, 2006)

The studied area is affected by multi directions of winds affecting Iraq(Al-Jeboury, 2002) analyzed the elements of climatology of Salaha Din province and concluded that the north westerly wind is the most common and frequent occurrence.

The first dust storms source is mainly by a northwest wind which called shamal which blows over Iraq and Arabian Gulf states. Shamal winds can last for several days, strengthen at the day and weakening at night, and creating devastating dust storms that impact Iraq.

Although most sand is picked up from Jordan and Syria.

Shamal occurs around May which drills huge depressions in desert sand dunes.

(Kadem et al. 2010) studied the sand dunes in Baiji town and its extension toward SE.

The wind trends during dust storms in Iraq were observed by (Khalaf,2004) during a period of (1941-1970) as in Table -4- which is concluded that most of the wind directions during dust storms is within the fourth sector or between North and Northwest as shown in Figure (8) and in Aqua satellite image in (Figure-9) .

Table-:4 The frequency percentage of wind direction in major four sectors in Tikrit city and Baiji Town within Salahadin province.(Khalaf,2004)

270-360		180-270		90-180		0-90		Recorded years	City
NW	N	SW	W	SE	S	NE	E		
57	8.1	0	15.1	15.1	0.9	3.4	0.4	1977-1996	Baiji Town
73.8	7.6	0	12.8	2.2	1.1	0.5	2	1988-1996	Tikrit City

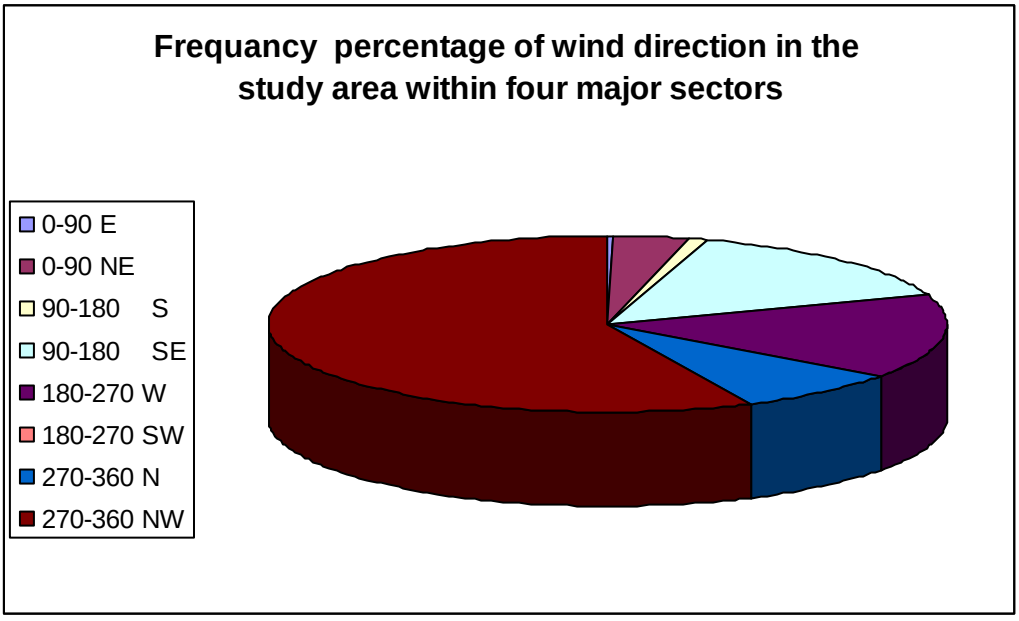


Figure – 8: The frequency percentage of wind directions within different sectors.

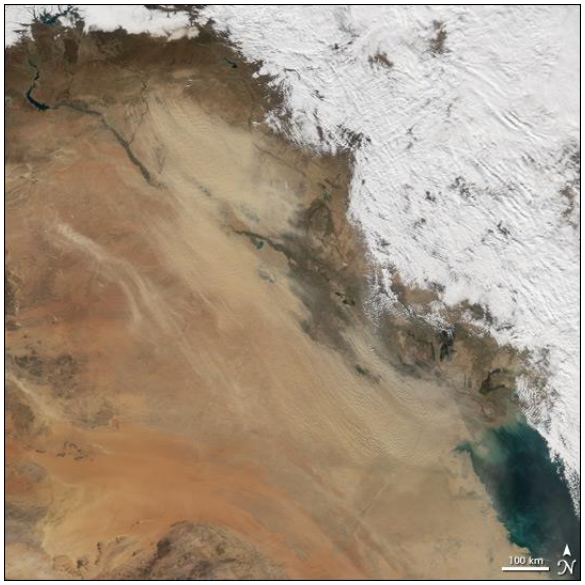


Figure -9: January 21, 2006, dust storm over Iraq (The source: Aqua satellite (MODIS) NASA).

To indicate the source of the dust and dust particles lifted up to the atmosphere and their transportation , as well as the weather elements, NOAA satellite images have been used For the study area the dust storm is detected with the (MODIS) Moderate Resolution Imaging Spectro radiometer during past years. From (Aqua satellite) on August 7,2005 (Figure - 10) shows the image with bands used are (1,4,3) , it shows the beginning of the dust and it extends towards south east and Terra satellite shows the extending of the storm towards south east the next day August 8,2005

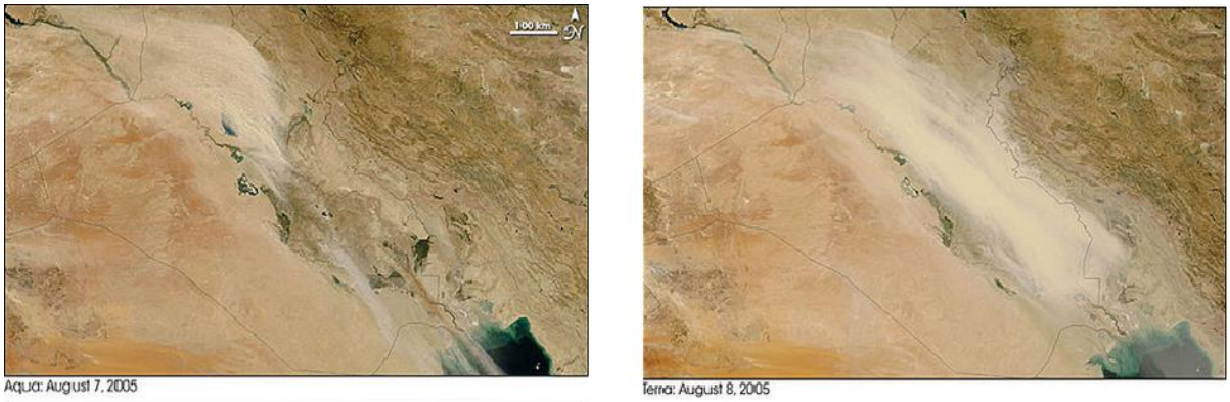


Figure-10: Detection of dust storm by Aqua satellite shows the beginning of dust storm on August 7.2005, Extending of the dust storm towards south east on August 8.2005 by Terra satellite.(Source: NASA Site)

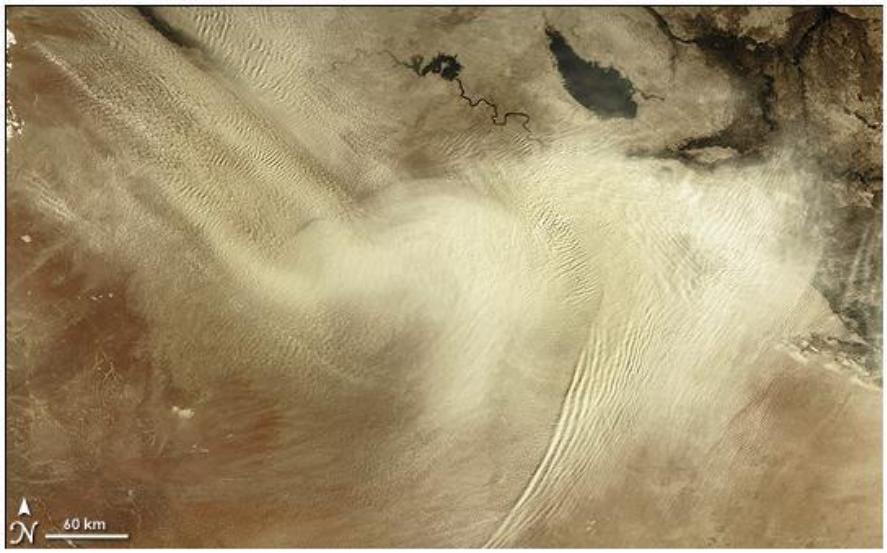


Figure-11: The desert in the west of Tikrit a large sandstorm swept over Iraq on September 14, 2008

The persistent summer wind is the northwest 'Shamal,' which occurs as a result of two circulating pressure centers, a low one over Iran Afghanistan and a high one over Saudi Arabia. The Gulf in between acts as a venturi for enhanced winds from surface level up to 5000 feet, and it is this force which brings so much dust haze into the country. The winds generally drop during the night. In the winter, winds are more variable but velocities are raised during storms caused by low pressure and passing jet streams.

Generally dust storms are caused by two major synoptic weather features: the 'Shamal' events described above, but also the persistence of deep low pressure over Empty Quarter region. The former event is illustrated through the following case study.

On Thursday morning, 17 May 2007, a violent dust storm broke out in many parts of the GULF. Suspended dust particles

reduced the visibility to considerable levels. Visibility plunged to record low levels in many regions, with Abu Dhabi topping the list with 500 meters and less. There was a marked rise in temperature too. This dust event was in fact initiated over the Tigris plain two days before , Figure (12) and (13). The Shamal winds transported the suspended clay and silt particles along their trajectory. Due to stability over UAE the dust deposition was entrained in the associated subsiding flow.

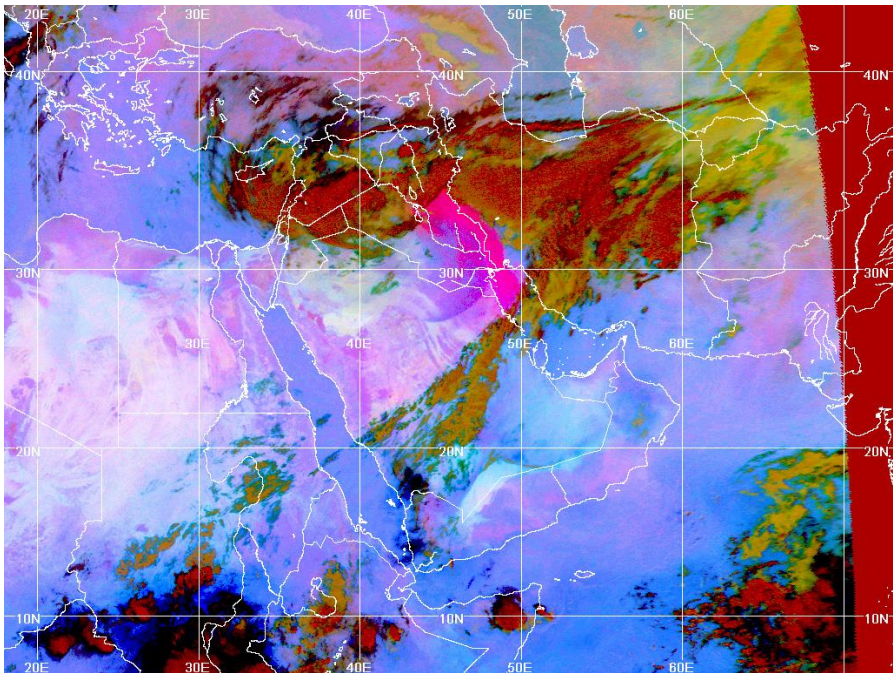


Figure -12 : ***Meteosat Satellite image showing a widespread dust pattern (violet color) initiated over Iraq on Thursday 17 May 2007 at 0600 UTC.*****(Al-Katheri, 2008)**

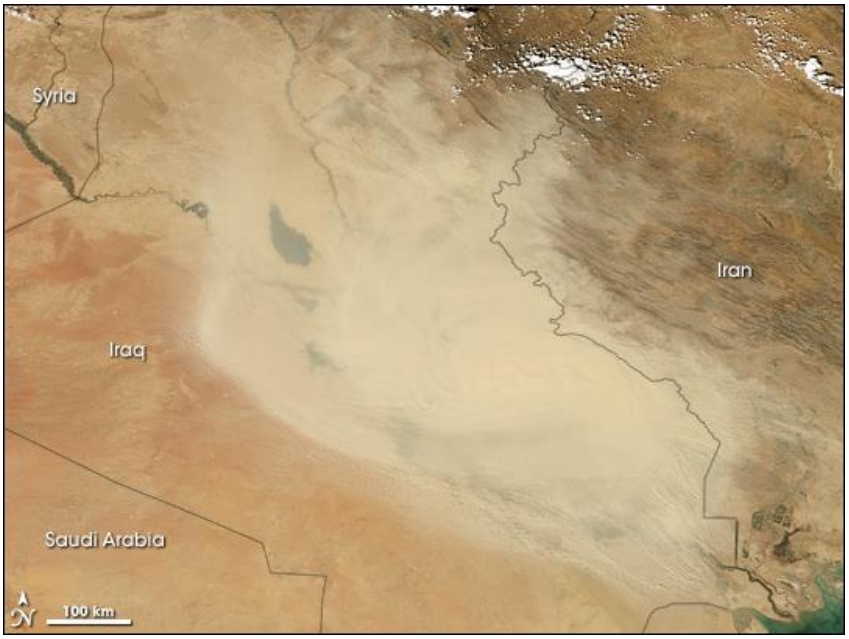


Fig -13: The Moderate Resolution Imaging Spectroradiometer (MODIS) shows the Junuary 21, 2006 dust storm crossed Iraq .

On January 21, 2006, a dust storm crossed Iraq toward the Arabian Gulf. Moving in a southeasterly direction, the storm moved over the city of Baghdad and the network of rivers, lakes, and wetlands to the southeast of the city. The Moderate Resolution Imaging Spectroradiometer (MODIS) flying onboard the Aqua satellite captured this image the same day. In this image, the dust appears as tendrils of pale beige, partially obscuring the underlying land areas. Immediately to the north and east of the dust storm is heavy cloud cover. Winds associated with weather systems can stir up dust storms in arid regions, so the dust storm and heavy cloud cover may be related

In this natural-color image, a nearly uniform cloud of dust obscures the view of northeastern Iraq and a small portion of Iran. The source points for the dust storm are not obvious from this image, although the fine sediments of the Tigris and Euphrates floodplain provide plentiful material for dust storms in this region. The second of dust sources is dust sediments transported from Syrian steppe which occupies an area of about 10 millions hectares, representing 55% of the country which is consequent changed in the recent decades due to destructed of the natural shrubby cover by tillage (Al-asker,1999), Figures (14 ,15) .

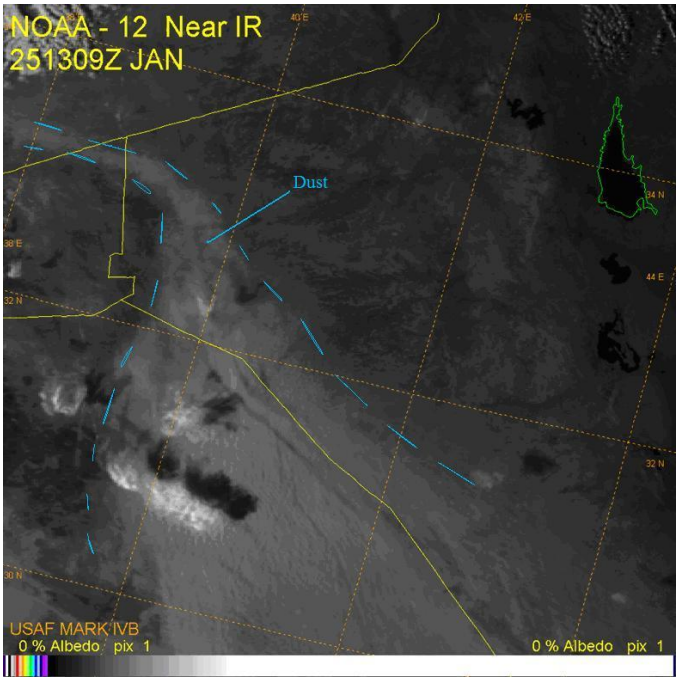


Figure – 14: A Near Infrared image of the dust storm entering Iraq. (NOAA).

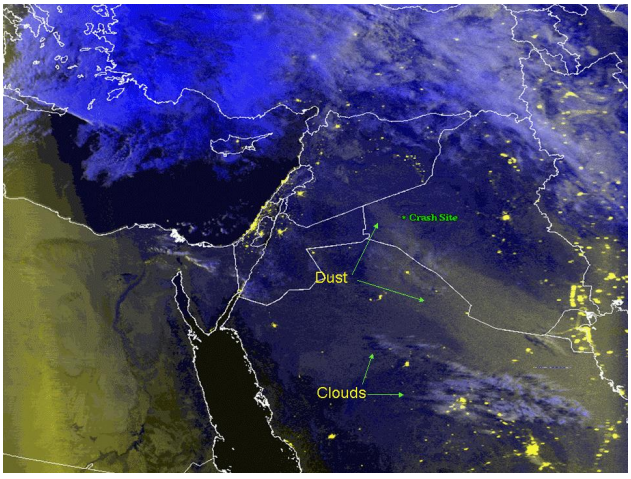


Figure -15: A Multi-spectral image (IR and Vis combined),of the dust .(NOAA).

In addition to the sources mentioned above the south westerly wind from Saudi Arabia increases in speed to raise the dust particles as a wall or as a mountain of dust as shown in (Figure-16). Transportation of fine-grained particles in suspension frequently occurs during dust storms usually initiated in southern Iraq.(*Geomorphology, Volume 6, Issue 2, January 1993,Pages111-134*F.I. Khalaf, D. Al-Ajmi).

Figure -16: The dust storm as a wall or as a mountain of dust (www.ImageIraqsandstorm-wikihow)

Dust storms can be a major contributor to reduced air quality and can cause hazards to human health. Wind-borne dust particles can invade the respiratory system's natural defenses and lodge in the bronchial tubes , increasing the number and severity of asthma attacks, causing or aggravating bronchitis, and reducing the body's). ability to fight infections. Dust storms can alsocause major ecological and agricultural damage. Figures (17),(18) and (19

Frequency of the Dust storms:

The monthly frequency distributions of dust storms in a period of two years Jan/2007 to Jan/2009 at Tikrit city were observed are shown in Figure 2. It is noted that the dust storm frequency more than a week per month is familiar in eight months in 2007 which begins in march and in 2008 in nine months as shown in (Table -1-)

Dust storm frequency and its relation to climate changes in northern China was studied by(Bao Yang et al.2007) ,which explained that in the semi-arid region the temperature and precipitation changes significantly correlated to the dust storm frequency. also precipitation patterns are changing which leads to frequent occurrence of dust storms.

Figure -17: shows the accumulation of dust particles in front of a house after taking a sample of the soil deposits .

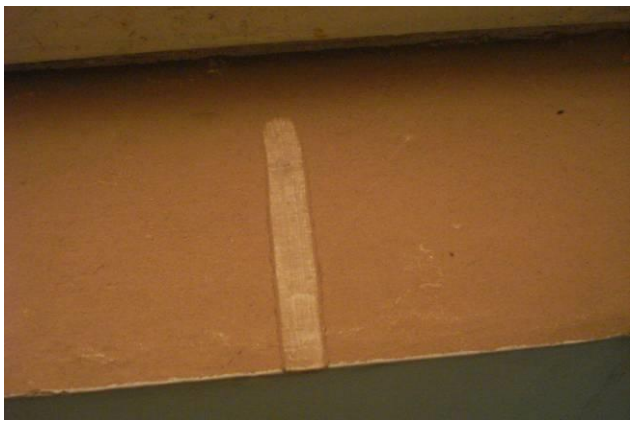


Figure-18: Deposition of dust particles indoors.

Figure -19: Dust storms reducing the visibility level to less than 500 meters.

Conclusions:

Based on meteorological, geological, sample analysis and remote sensing data the present study concluded:

1-The dust storms frequency is increasing to more than a week per month during nine months in a year.
2-The quantity of the dust accumulated in the end of a dust storm ranges between(107.44-452.44) gm./m2.
3-The distribution of the particle size of the dusts was calculated, which included 23.52% fine sand, 62.6%silt and 13.88% clay.
4-From the X-Ray Diffraction of the dust mineral constituents were recognized which included quartz and silica, calcite and dolomite, feldspars, montmorilonite and kaolinite and palygorskite
5-The dust storms sources were indicated by using different satellite images and Iraq affected by multi directions of winds especially the north westerly wind which is the most common.

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